

**CLAIMS**

**What Is Claimed Is:**

5        1. In an implantable cardiac stimulation device having a pulse generator for generating pacing pulses for applying to the heart of a patient and having a control circuit for controlling the pulse generator to apply overdrive pacing pulses to the heart, a method comprising:

10              inputting an initial shape for an overdrive pacing response function for use in overdrive pacing the heart;

                    controlling the pulse generator to overdrive pace the heart at an overdrive pacing rate specified by the shape of the overdrive pacing response function;

                    determining whether the degree of overdrive pacing achieved using the overdrive pacing response function falls below a threshold; and

                    adjusting the shape of the overdrive pacing response function so as to improve the degree of overdrive pacing to be achieved during further overdrive pacing if the degree of overdrive 20              pacing falls below the threshold.

2. The method of claim 1 wherein inputting an initial shape for the overdrive pacing response function comprises inputting a set of values specifying overdrive pacing rates corresponding to detected heart 25              rates throughout a range of detectable heart rates.

3. The method of claim 1 further comprising adjusting the shape of the overdrive pacing response function if the degree of overdrive pacing falls outside of a range of values.

4. The method of claim 1 wherein controlling the pulse generator to overdrive pace the heart at the overdrive pacing rate specified by the overdrive pacing response function comprises:

- 5           a) detecting an event triggering overdrive pacing;
- b) detecting the heart rate;
- c) evaluating the overdrive pacing response function to determine the particular overdrive pacing rate corresponding to the detected heart rate;
- d) controlling the pulse generator to pace the heart at the particular overdrive pacing rate for a predetermined number of paced beats; and
- e) controlling the pulse generator to decrease the pacing rate until another event triggering overdrive pacing is detected then repeating a) - e).

15           5. The method of claim 4 wherein detecting an event triggering overdrive pacing comprises detecting a predetermined number of intrinsic heartbeats within a predetermined period of time.

20           6. The method of claim 1 wherein determining the degree of overdrive pacing achieved using the overdrive pacing response function comprises:

              tracking the heart rate; and  
              for each of a set of predetermined ranges of heart rates,  
25           determining an overdrive pacing ratio indicative of the paced heartbeats to total heartbeats.

30           7. The method of claim 6 wherein tracking the heart rate is performed over a period of 24 to 48 hours.

200901070674-A1

8. The method of claim 1 wherein adjusting the shape of the overdrive pacing response function comprises:

inputting an optimal range of overdrive pacing;

comparing the detected degree of overdrive pacing with the

5 optimal range of overdrive pacing for each of a set of predetermined heart rate ranges;

if the detected degree of overdrive pacing exceeds the optimal range of overdrive pacing for a particular heart rate range, decreasing the overdrive pacing rate of the overdrive pacing

10 response function corresponding to the particular heart rate range; and

if the detected degree of overdrive pacing is below the optimal range of overdrive pacing for a particular heart rate range, increasing the overdrive pacing rate of the overdrive pacing

15 response function corresponding to the particular heart rate range.

9. The method of claim 8 wherein the optimal range of overdrive pacing is specified as a range of percentages of paced beats to total beats.

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10. The method of claim 8 wherein the optimal overdrive percentage range of percentages is 85% to 95%.

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11. An implantable cardiac stimulation device comprising:

a pulse generator that is operative to generate pacing

pulses to be applied to the heart of a patient; and

a control circuit that is operative to control the pulse generator to apply overdrive pacing pulses to the heart using an overdrive pacing response function and that automatically and

dynamically adjusts the shape of the response function so that a degree of overdrive pacing exceeds a threshold value.

12. The device of claim 11 wherein the control circuit comprises  
5 an overdrive pacing unit operative to:

input an initial shape for the overdrive pacing response function;  
control the pulse generator to overdrive pace the heart at an  
overdrive pacing rate specified by the initial shape of the overdrive pacing  
response function;

10 determine the degree of overdrive pacing achieved using the  
overdrive pacing response function; and

adjust the shape of the overdrive pacing response function so as  
to improve the degree of overdrive pacing to be achieved during further  
overdrive pacing.

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13. The device of claim 12 wherein the shape for the overdrive  
pacing response function is specified by a set of values of overdrive  
pacing rates each corresponding to detected heart rates throughout a  
range of detectable heart rates.

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14. The device of claim 13 wherein the set of values specifying  
overdrive pacing rates comprises a set of break points specifying  
overdrive rates only for a particular set of heart rates within the range of  
detectable heart rates and wherein the overdrive pacing unit determines  
25 overdrive pacing rates for other heart rates within the range of detectable  
heart rates by interpolation.

30 15. The device of claim 12 wherein the overdrive pacing unit  
operates to determine the degree of overdrive pacing achieved using the  
overdrive pacing response function by tracking the heart rate and, for

each of a set of predetermined ranges of heart rates, to determine an overdrive pacing percentage indicative of the paced heartbeats to total heartbeats.

5        16. The device of claim 12 wherein the overdrive pacing unit operates to adjust the shape of the overdrive pacing response function by comparing the detected degree of overdrive pacing with an optimal range of overdrive pacing for each of a predetermined set of heart rate ranges, decreasing the overdrive pacing rate of the overdrive pacing response 10 function corresponding to a particular heart rate range when the detected degree of overdrive pacing exceeds the optimal range of overdrive pacing for the particular heart rate range, and increasing the overdrive pacing rate of the overdrive pacing response function corresponding to the heart rates of a particular heart rate range when the detected degree of 15 overdrive pacing is below the optimal range of overdrive pacing for the particular heart rate range.

17. An implantable cardiac stimulation device comprising:  
means for generating pacing pulses to be applied to the  
20 heart of a patient;  
means for controlling the means for generating pulses to overdrive pace the heart at an overdrive pacing rate specified by an overdrive pacing response function;  
means for determining the degree of overdrive pacing  
25 achieved using the overdrive pacing response function; and  
means for adjusting the shape of the overdrive pacing response function so as to improve the degree of overdrive pacing to be achieved during further overdrive pacing if the degree of overdrive pacing falls below a threshold value.

18. The device of claim 17 wherein the means for adjusting the shape of the overdrive pacing response function comprises:

means for inputting an optimal range of overdrive pacing;

means for comparing the detected degree of overdrive

5       pacing with the optimal range of overdrive pacing for each of a set of predetermined heart rate ranges;

means, responsive to a determination that the detected degree of overdrive pacing exceeds the optimal range of overdrive pacing for a particular heart rate range, for decreasing the

10      overdrive pacing rate of the overdrive pacing response function corresponding to the particular heart rate range; and

means, responsive to a determination that the degree of overdrive pacing is below the optimal range of overdrive pacing for a particular heart rate range, for increasing the overdrive pacing rate of the overdrive pacing response function corresponding to the particular heart rate range.

19. In an implantable cardiac stimulation device, a method comprising:

20       pacing a heart at an overdrive pacing rate specified by an overdrive pacing response function;

          determining whether the degree of overdrive pacing achieved using the overdrive pacing response function falls below a threshold; and

25       adjusting the overdrive pacing response function if the degree of overdrive pacing falls below the threshold; and

          using the adjusted overdrive pacing response function for further overdrive pacing.